

# AFRL Update on Status of Cr-Free Coating Systems

**ASSETS Defense**  
**29 August 2012**



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# Presentation Outline



Public Affairs release # 88ABW-2008-0909

- **Approved Non-Chrome Coatings**
- **Issues with Non-Chrome Coating Systems**
  - **Unclear Requirement**
  - **Problems Developed**
    - **Non-Chrome not as Robust as Chrome**
    - **Lab Results don't Translate to Real World**
    - **Not All Aircraft are Created Equal**
- **AFRL Path Forward**
- **PreKote/Mg-Rich Coating System**
- **Current Field Testing**



# USAF Approved Non-chrome Coatings



Public Affairs release # 88ABW-2008-0909

- **Authorized Non-chrome Pretreatments**

- PreKote approved – T.O. 1-1-8

Authorized for use  
under a Chrome Primer

- **Qualified Non-Chrome Primers**

- MIL-PRF-85582 Class N Primers

- Type I, EWDY048
  - Type II, EEAE118
  - 44-GN-098, Deft
- } PRC DeSoto

Qualified over a Chrome  
Conversion Coating

- MIL-PRF-23377 Class N Primers

- 16798-TEP, Hentzen
  - 02-GN-083
  - 02-GN-084
- } Deft

**Result: NO QUALIFIED COMPLETE NON-CHROME COATING SYSTEM**  
(Pretreatment/Primer/Topcoat)



# Issues with Non-Chrome



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- **Chrome Inhibitors are a Technology**
  - **Much Characterization before Specifications**
    - **Pretreatment MIL-PRF-81706**
    - **Primer MIL-PRF-23377 or MIL-PRF-85582**
    - **Topcoat MIL-PRF-85285**
  - **Robust could mix and match with little variance in performance**



# Unclear Requirement

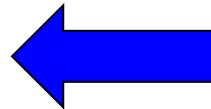


Public Affairs release # 88ABW-2008-0909

617-A1A-004

**2000 hours Salt Spray**  
**Complete Chrome System**

**MIL-DTL-81706**  
**MIL-PRF-23377, Class C2**  
**MIL-PRF-85285**



**MIL-DTL-81706**  
**MIL-PRF-23377, Class C2**  
**Deft APC**



2024 T-3 Aluminum

617-A1B-005

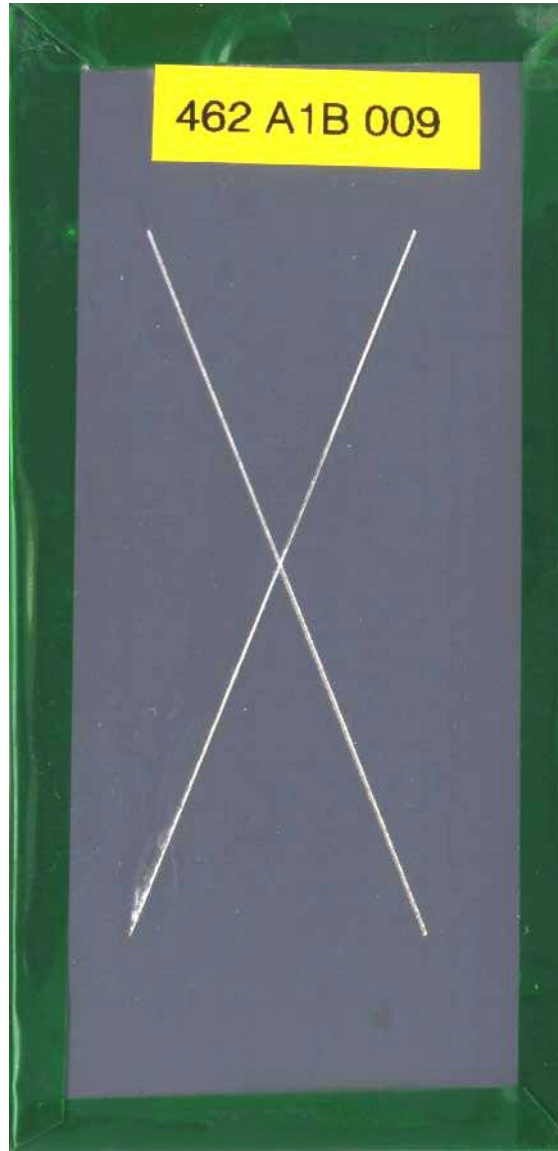
2024 T-3 Aluminum



# Unclear Requirement

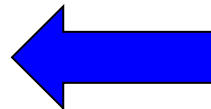


Public Affairs release # 88ABW-2008-0909



**4032 hours Salt Spray**  
**Complete Chrome System**

**MIL-DTL-81706**  
**MIL-PRF-23377, Class C2**  
**MIL-PRF-85285**



**MIL-DTL-81706**  
**MIL-PRF-23377, Class C2**  
**Deft APC**





# Unclear Requirement



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- **First Versions of MIL-C-23377**
  - **No Salt Fog Test**
  - **Formula Specification – Specified Amount of Chrome**
- **Blistering of MIL-C-23377**
  - **Added Humidity Test**
  - **Added Salt Fog Test – 1000hrs**
- **Acquisition Reform**
  - **Push to go to Performance Specifications**
    - **Removed Specified Amount of Chrome Requirement**
    - **Salt Fog Test – 2000hrs**
      - **Engineering Rule of Thumb – Double Requirement**





# Unclear Requirement



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- **Non-Chrome is NOT a Technology**
  - **Each Non-Chrome Coating System is a Technology**
    - New technologies require characterization, sub-system field test, full up field test, etc
    - Then specifications built around that technology
  - **But, that is not what happened**
    - If pass salt spray, 2000hrs, then good to go
    - Chrome Coating Specifications modified to include a type for Non-chrome
  - **Problems developed**
    - **Changing components** of the system yielded big differences
    - Success in **lab tests did not translate** to outdoor exposure
    - Some success with **JGAPP primers** on F-15 but failure on KC-135
      - Pre-existing corrosion on OML of KC-135



# Results of Changing Components



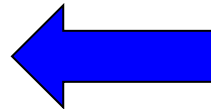
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633-A1A-003

3000 hours Salt Spray

MIL-DTL-81706  
MIL-PRF-23377, Class C2  
Deft APC

Complete Chrome  
System



MIL-DTL-81706  
Deft 02-GN-084  
Deft APC

Non- Chrome Primer



633-A1C-001

2024 T-3 Aluminum

2024 T-3 Aluminum



# Results of Changing Components



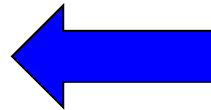
Public Affairs release # 88ABW-2008-0909

633-A1C-001

3000 hours Salt Spray

MIL-DTL-81706  
Deft 02-GN-084  
Deft APC

Non- Chrome Primer



PreKote  
Deft 02-GN-084  
Deft APC

Complete Non- Chrome  
System



633-A1N-003

2024 T-3 Aluminum



# Results of Changing Components



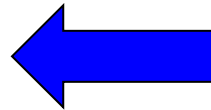
Public Affairs release # 88ABW-2008-0909

633-A1C-001

3000 hours Salt Spray

MIL-DTL-81706  
Deft 02-GN-084  
Deft APC

Non- Chrome Primer



BoeGel  
Deft 02-GN-084  
Deft APC

Complete Non- Chrome  
System



633-A1I-003

Blisters in Field

2024 T-3 Aluminum

2024 T-3 Aluminum



# Lab Results vs Real World



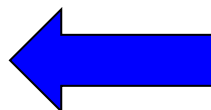
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617-A1B-005

**2000 hours Salt Spray**

**MIL-DTL-81706  
MIL-PRF-23377, Class C2  
Deft APC**

**Complete Chrome  
System**



**Alodine 5200  
Sicopoxy 577-630  
Deft APC**

**Complete Non- Chrome  
System**



617-A1X-005

2024 T-3 Aluminum

2024 T-3 Aluminum



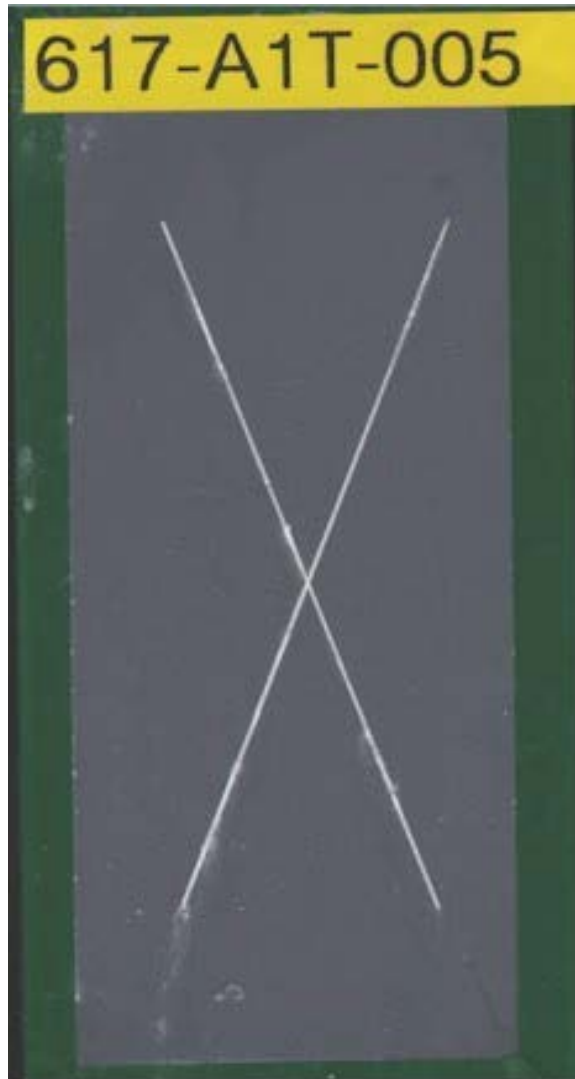


# Lab Results vs Real World



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**Laboratory Salt Fog 2000 hrs**



**Outdoor Exposure After 3+ Years At Daytona  
(Failure <1 year)**



**Alodine 5200**  
**Sicopoxy 577-630**  
**Deft 03GY310**  
(MIL-PRF-85285 Ty 1)



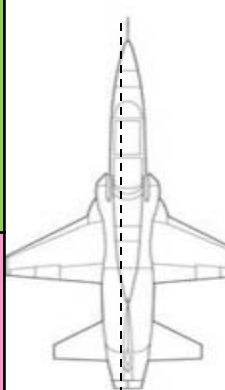
# AFRL Chromium-free Coating Systems Integration Plan Efforts



Public Affairs release # 88ABW-2008-0909

## “Sicopoxy” Flight Test with T-38 at Randolph AFB (2008-2009)

- ✓ Conduct a field test to evaluate the capabilities of the selected non-chrome coating system against the standard coating system

Chromium Control		Chromium-free	
PreKote (3 Step Process)		Brulin 815GD Cleaner	
		Alodine 5700 Non-chrome Conversion Coat	
MIL-PRF-23377 Primer Sherwin Williams E90-G-203		ANAC 577-630 Non-Chrome Primer	
Topcoats Deft MIL-PRF-85285 (03-GY-308 and 03-GY-277)			



# AFRL Chromium-free Coating Systems Integration Plan Efforts



Public Affairs release # 88ABW-2008-0909

## T-38, Randolph AFB (Sep 2008)

Control Side

Test Side



- ✓ Aircraft looked good - no visual difference between control and test side
- ✓ Dry film thicknesses (3.06 mils test side, 3.96 mils control side), color, and gloss were taken
- ✓ Witness panels with both processes were taken for laboratory testing

**No difference between Chrome system and Non-Chrome system Sept 2010**





# Issues with JGAPP NCr

## (Chrome can Arrest Existing Corrosion)



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- **JGAPP – KC-135 Field Test**
  - Hickam AFB
  - Half & Half
    - Chrome/Non-Chrome



- **Corrosion in Center of Skins**
  - Existing Corrosion Pits
  - NCr Could NOT Prevent
- **Sent Back to Depot**
  - Out of Cycle = Big Dollars

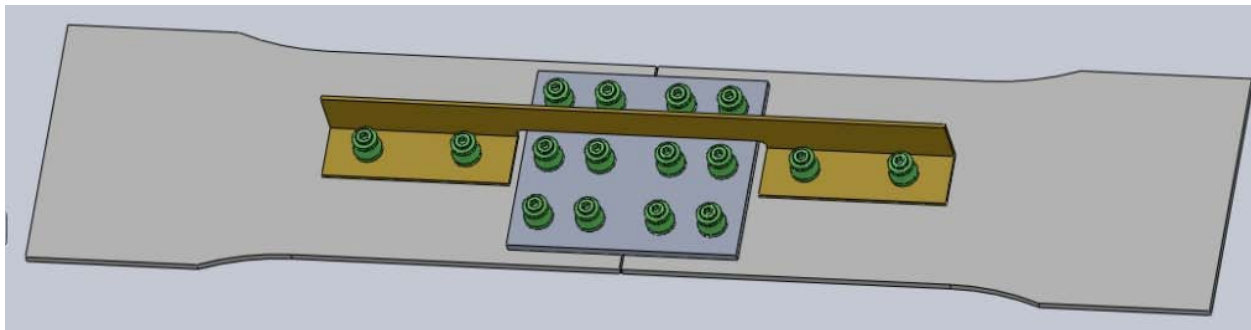


# AFRL Path Forward



Public Affairs release # 88ABW-2008-0909

- **Coating System Specification - MIL-PRF-32239 (Outer Moldline Only)**
  - Eliminates issues with mixing components of a coating system
- **Develop Better Laboratory Test Methods – 3 Prongs**
  - Better Salt Fog Cabinet – Include UV
  - Family of Test Coupons to Represent Aircraft Structures and Loads
    - Initial Focus is KC-46 Fuselage
  - Evaluation Techniques – NDI, Corrosion Modeling – Feeds ASIP Models





# AFRL Path Forward



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- **Under Secretary of Defense, Mr. Young Letter**
- **Defense Acquisition Regulations System, 48 CFR Parts 223 and 252**
- **Non-Chrome Characterization Effort – Need to Reduce Risk**
  - 9 Non-Chrome Coating Systems
  - Laboratory Testing to MIL-PRF-32239
  - Extensive Outdoor Exposure Testing
    - 2024 and 7075 Scribed Panels
    - Pre-Corroded Panels
    - Fresh Anodized Panels
    - C-5 Skins – Anodized, Partial Primer
    - Panels with Fasteners
    - Battelle Sensors
  - Sea Water Spray and Without – Overhang (3X)

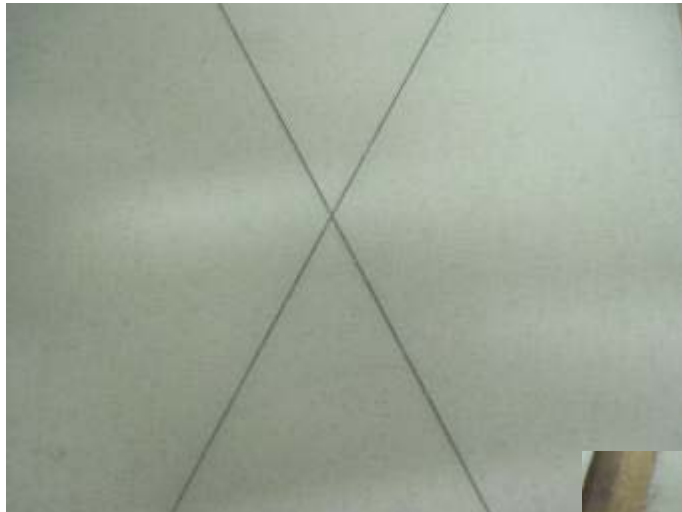


# Outdoor Exposure

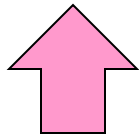
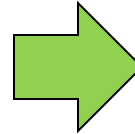


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## Painted 2024 Al Panels After 3+ Years At Daytona



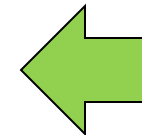
Prekote/  
AE 2100/  
85285 Ty IV AE 5000



Chrome Control  
81706/  
23377, CI C2/  
85285 Ty I Deft 03GY310



Alodine 5200/  
Sicopoxy/  
85285 Ty I Deft 03GY310  
(Failure <1 Year)





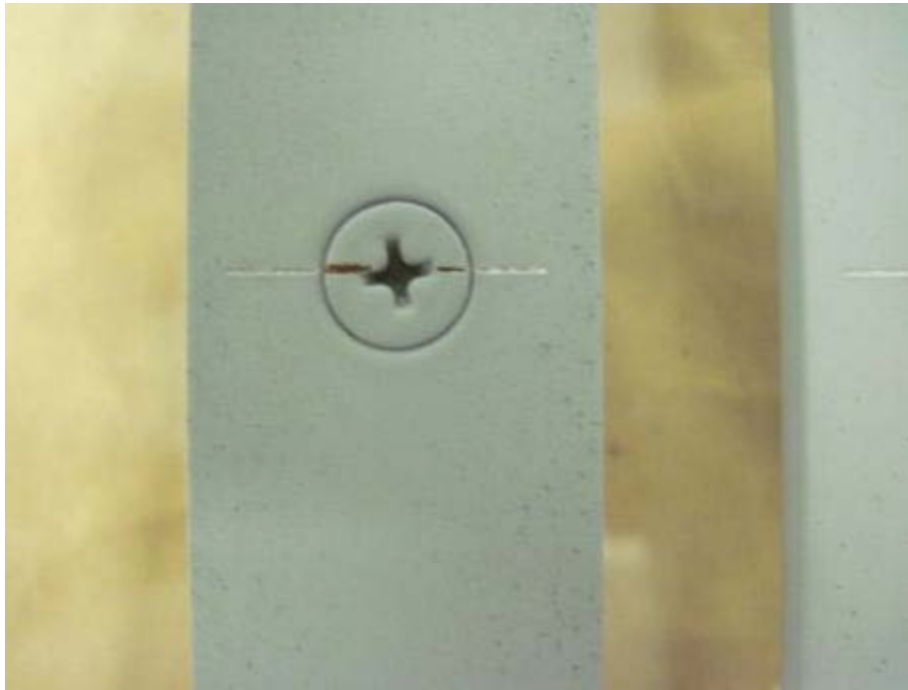
# Outdoor Exposure



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## Galvanic Test Samples Exposed at Daytona

2024-T3 Al with Cd Plated Steel Screws  
Proven Very Effective In Discriminating  
Among Paint Systems and Quickly  
Failures <1 Year



System 2; Prekote/AE 2100/85285 Ty IV AE 5000  
NC/NC; 2 Years



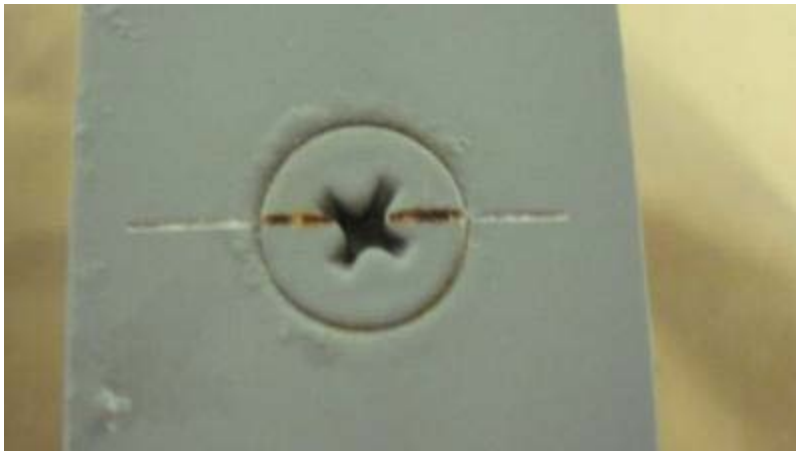
System 4 5541/23377, CI C2/  
85285 Ty I 03GY310 C/C; 2 Years



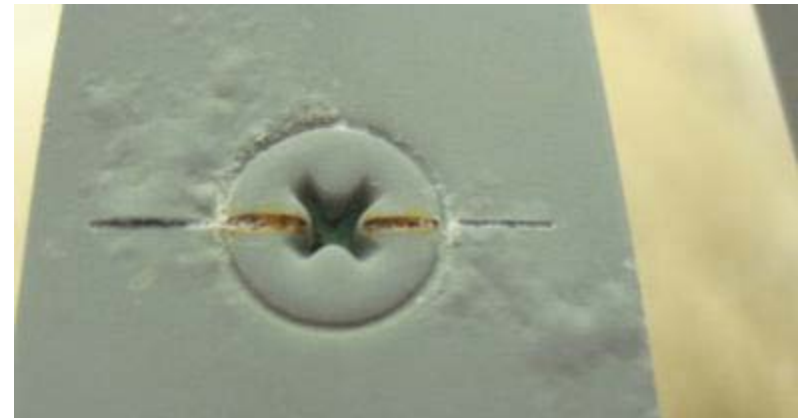
# Outdoor Exposure



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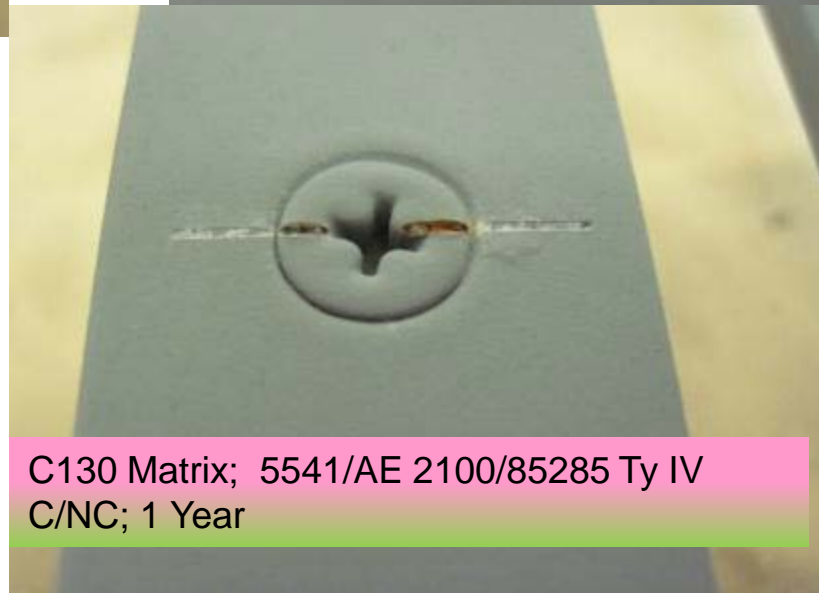
System 6 Prekote/Americoat/85285 Ty I  
NC/NC; 2 Years



C130 Matrix; 5541/85582 CI N/85285 Ty IV  
C/NC; 1 Year

**NOTE:** AE 2100 requires good conductivity with substrate.

AE 2100 **NOT** recommended over conversion coating.



C130 Matrix; 5541/AE 2100/85285 Ty IV  
C/NC; 1 Year





# Outdoor Exposure



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## KC-135 Upper Wing Skins; Painted and Scribed; 2+ Years ; Daytona



**System 4;** C/C/85285, Ty IV  
Middle

**System 5;** Alodine 5200/Sicopoxy/85285,  
Ty IV Lower

**System 2;** PreKote/AE 2100/85285, Ty IV  
Upper

**System 4;** C/C/85285, Ty IV Lower



# Outdoor Exposure



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Magnified  
view of  
fasteners  
(2+ Years)

System 2; PreKote/AE2100/85285, Ty IV Deft ELT



System 4; C/C/85285, Ty IV Deft ELT







# Mg-Rich Implementation



Public Affairs release # 88ABW-2008-0909

- **Norwegian Air Force – Jan 2012**
  - Performed best of all non-chrome tested
  - Approved for use
- **Germany Approval – May 2012**
  - Specification TL8010-0046
  - Used on Tornado and P3-C Orion
- **Italian Air Force – July 2012**
  - 30 C-130 to be painted



# First Norwegian C-130



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After application of the  
Aerodur 2100MgRp



C130 AMI "VEGA 58"  
Completely Painted





# C-130 Field Testing



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- **5 Aircraft Scheduled**
  - **Complete coverage of aircraft with test coating**
  - **2 Complete**
    - **20 Aug 2011 -- WR-ALC – Elmendorf AI**
      - **PreKote/ANAC Aerodur 2100/ANAC Aerodur 5000**
    - **7 May 2012 -- WR-ALC – Hurlburt FI**
      - **RECC 1015 (DeOX)/RECC 3021 (Pretreat)/Deft 02-GN-093/Deft 99-GY-XXX ELT**



# F-16 Field Testing



Public Affairs release # 88ABW-2008-0909

- **In Planning Stage**
- **5 Aircraft**
- **4 Test Coatings, 1 Control**
  - 4 - Pretreatments and Primers
  - 1 - 5541/23377
- **Standard F-16 Topcoat**
  - MIL-PRF-85285 Ty IV
- **Coatings Rotate to Different Locations**
- **Test Duration = PDM Cycle**
  - 6 Years

